

Psychomotor Vigilance Test (PVT) on ISS

Completed Technology Project (2008 - 2017)



Project Introduction

The Psychomotor Vigilance (PVT) Self Test (operational name on International Space Station (ISS) is Reaction Self Test (RST)) is intended to provide astronauts in spaceflight with objective feedback on neurobehavioral changes in vigilant attention, psychomotor speed, state stability, and impulsivity while on ISS missions, as well as recording their subjective ratings of workload, sleep timing and quality, tiredness, fatigue, and stress. The PVT Self Test is suited for repeated use in spaceflight because unlike other cognitive tests, it is very brief (less than 5 minutes) while being free of learning effects and aptitude differences that make interpretation of other cognitive measures difficult.

Our initial Reaction Self Test study evaluated 24 astronauts, before, during, and after 6-month missions on the International Space Station (ISS). A total of 2,856 RST evaluations were obtained from 21 astronauts participating in 6-month ISS missions.

To determine whether there were continuing changes in Reaction Self Test outcomes for ISS missions greater than 6-month duration, a study was conducted on the RST outcomes of N=2 participants in the initial 1-year mission (i.e., one US astronaut and one Russian cosmonaut). The following are the objectives (specific aims) of the project for the 1-year mission. The US astronaut and Russian cosmonaut were evaluated within the 1-year mission, and relative to data from the N=21 astronauts in 6-month missions.

- 1) Evaluate whether there were changes in sleep duration and/or sleep quality within the 1-year mission (i.e., first 6 months compared to the second 6 months of the 1-year mission), and differences in these outcomes between the 1-year and 6-month missions.
- 2) Evaluate whether there were changes in psychomotor speed, performance lapses, and premature responses on the Brief Psychomotor Vigilance Test (PVT-B) within the 1-year mission (i.e., first 6 months compared to the second 6 months of the 1-year mission), and differences in these outcomes between the 1-year and 6-month missions.
- 3) Evaluate whether there were changes in subjective ratings of sleepiness, fatigue, tiredness, physical exhaustion, workload, and stress within the 1-year mission (i.e., first 6 months compared to the second 6 months of the 1-year mission), and differences in these outcomes between the 1-year and 6-month missions.
- 4) To investigate changes in the intake of caffeine and medications within the 1-year mission (i.e., first 6 months compared to the second 6 months of the 1-year mission), and differences in these outcomes between the 1-year and 6-month missions.



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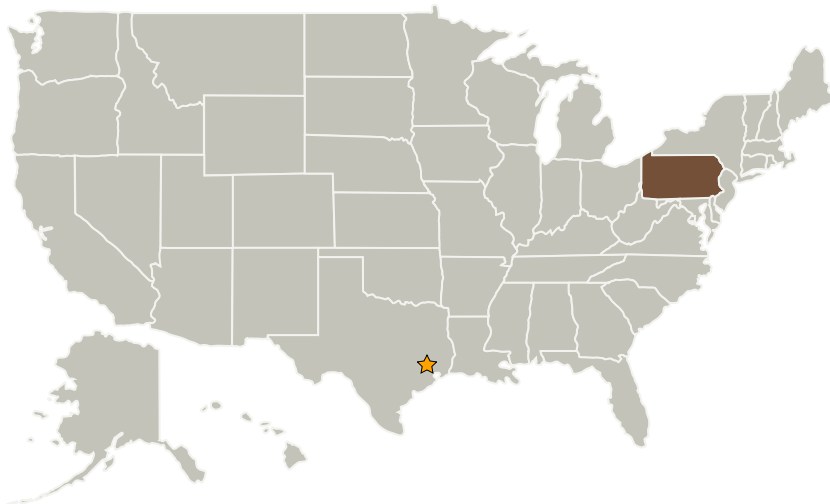


Anticipated Benefits

The Principal Investigator (PI) developed the original 10-minute Psychomotor Vigilance Test (PVT), from which the Reaction Self Test was derived, to measure changes in psychomotor speed, lapses of attention, wake state instability, and impulsivity induced by fatigue and other performance-degrading factors commonly found in operational environments. Based on research supported by federal and non-US federal agencies, as well as the pharmaceutical industry, the 10-minute PVT has been extensively validated in laboratory studies, simulators, and operational environments to be sensitive to a variety of performance-degrading fatigue-related factors. There are currently more than 200 published peer-review papers on the sensitivity of the 10-min. PVT to fatigue-related factors.

The Reaction Self Test is a 3-minute PVT Self Test that contains special timing and algorithm characteristics and that has been validated against the 10-minute PVT. The 3-minute Reaction Self Test will have utility in a wide array of safety-sensitive environments on Earth. Potentially any occupation in which alertness and fatigue management are essential to prevent errors on critical tasks will benefit from adaptations of the PVT SelfTest technology (e.g., certain military personnel, airport security screeners, physicians on night shifts and prolonged call).

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Operations Mission Directorate (SOMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Human Spaceflight Capabilities

Project Management

Program Director:

David K Baumann

Project Manager:

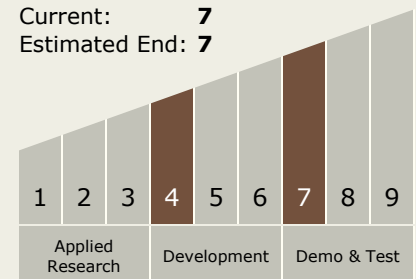
Thomas J Williams

Principal Investigator:

David F Dinges

Technology Maturity (TRL)

Start: 4
Current: 7
Estimated End: 7



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Organizations Performing Work	Role	Type	Location
★ Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
University of Pennsylvania	Supporting Organization	Academia	Philadelphia, Pennsylvania
University of Pennsylvania School of Medicine	Supporting Organization	Academia	Pennsylvania

Primary U.S. Work Locations

Pennsylvania

Project Transitions

**August 2008:** Project Start

Technology Areas

Primary:

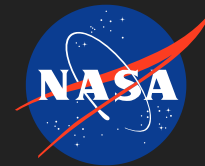
- TX06 Human Health, Life Support, and Habitation Systems
 - └ TX06.3 Human Health and Performance
 - └ TX06.3.3 Behavioral Health and Performance

Target Destinations

The Moon, Mars

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 **December 2017:** Closed out

Closeout Summary: Data obtained from the RST project included: Time in Bed, Total Sleep Time, Poor Sleep Quality, Sleepiness, Tiredness, Fatigue, Physical Exhaustion, Stress, Workload, Caffeine Consumption, PVT Response Speed, PVT Lapses, PVT Premature Responses, and PVT Performance Score. No medications were reported by either astronaut. Linear mixed effect models with random subject effect were created using SAS version 9.3 and adjusted only for administration time (morning/evening). The five groups that were compared were: N=21 astronauts with valid data from the PVT on ISS 6-month mission, first 6 months of data from astronaut Y, second 6 months of data from astronaut Y, first 6 months of data from astronaut Z, and second 6 months of data from astronaut Z. Paired t-tests were used to compare the first and second 6-month periods for astronaut Y and to compare the first and second 6-month periods for astronaut Z. Independent t-tests were used to compare data from N=21 astronauts on the 6-month mission with the first and second 6-month periods for astronaut Y, and to compare data from N=21 astronauts from the 6-month mission with the first and second 6-month periods for astronaut Z. Astronaut Y had no significant changes from the first 6 months to the second 6 months in the following in-flight VAS scales: Time in Bed (TIB), Total Sleep Time (TST), Poor Sleep Quality, Sleepiness, Tiredness, Fatigue, Physical Exhaustion, and Workload. Astronaut Y did, however, have a significant increase in subjective Stress ratings from the first 6 months to the second 6 months in-flight. Relative to PVT-B performance, Astronaut Y had no significant changes from the first to the second 6 months of the 1-year mission in PVT Response Speed or PVT Premature Responses. However, Astronaut Y did have significantly more PVT Lapses in the second 6 months of the mission. Moreover, Astronaut Y had significantly more PVT Lapses in both six month periods of the 1-year mission relative to the N=21 astronauts who undertook 6-month ISS missions. Therefore, Astronaut Y had a lower overall PVT-B Performance Score than the N=21 astronauts from the 6-month mission. Astronaut Z had no significant changes from the first 6 months to the second 6 months in the following in-flight VAS scales: TST, Poor Sleep Quality, Tiredness, and Fatigue. Astronaut Z did, however, have a significant decrease in TIB, increase in Sleepiness, increase in Physical Exhaustion, decrease in Stress, increase in Workload, and decrease in Caffeine Consumption in the second 6 months relative to the first 6 months. Relative to PVT-B Performance, Astronaut Z had no significant changes from the first 6 months to the second 6 months of the 1-year mission in PVT Response Speed or PVT Premature Responses. However, Astronaut Z did have significantly less PVT Premature Responses in the second 6 months of the mission. Therefore, Astronaut Z had a significant increase in PVT Performance Score in the second 6 months relative to the first 6 months of the mission. The PVT-B Performance Score of Astronaut Y was more adversely affected by Slam shifts during the first 6 months of the mission than was PVT-B Performance of Astronaut Z.

Stories

Abstracts for Journals and Proceedings
(<https://techport.nasa.gov/file/60370>)

Abstracts for Journals and Proceedings
(<https://techport.nasa.gov/file/60372>)

Abstracts for Journals and Proceedings
(<https://techport.nasa.gov/file/60359>)

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Articles in Peer-reviewed Journals
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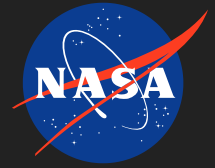
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Articles in Peer-reviewed Journals
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Articles in Peer-reviewed Journals
(<https://techport.nasa.gov/file/60351>)

Awards
(<https://techport.nasa.gov/file/60361>)

Project Website:

<https://taskbook.nasaprs.com>